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ABSTRACT

An auditory perception study investigated the ability of 104 Japanese university students, all learners of English as a second language, to distinguish between five English voiceless fricatives in nonsense syllables. Stimuli consisted of 75 tokens presented in consonant-vowel, vowel-consonant-vowel, and vowel-consonant syllables spoken within a varied-vowels environment and recorded by three native speakers of English. Response rates for each of the target sounds varied from 55 percent to 88 percent. Certain consonants posed greater difficulty than others, particularly in specific phonological environments. (MSE)

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RECOGNITION OF VOICELESS FRICATIVES BY JAPANESE L2 LEARNERS

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1. INTRODUCTION

This paper presents the preliminary results of a perception test which was administered to 104 Japanese adult learners to examine their ability to distinguish between the English fricatives /f/, /θ/, /s/, /ʃ/, and /h/ in nonsense syllables. The stimuli consisted of 75 tokens (a total of over 23,000 responses) presented in consonant-vowel (CV), vowel-consonant-vowel (VCV) and vowel-consonant (VC) syllables spoken within a varied-vowel environment /ɪ ɛ a u o/ and recorded by three native speakers of English. Overall, the listener judgments observed in the perceptual experiment indicated the following response rates for each of the target sounds: /f/: (79%), /s/: (72%), /ʃ/: (88%), /θ/: (55%), and /h/: (79%).

2. METHOD

Subjects

The subjects were 104 Japanese adults ranging in age from 18 to 20 years old. They were first year students at the University of Aizu in Japan and were taking a course in English pronunciation. As is common in Japan, all had six years of prior English training at the junior and senior high school levels. The subjects had little or no formal training in English pronunciation. None of the subjects had any known speech or hearing impediments.

Recording Method

The speech samples were generated using a binaural recording system located in a large anechoic chamber at the University of Aizu. The talker was located approximately 2 meters from the Brüel & Kjær Head and Torso Simulator (Type 4128), using the Right Ear Simulator (Type 4158) and the Left Ear Simulator (Type 4159). The talker was positioned at ear level, but slightly off the median plane of the mannequin, at an azimuth angle of approximately 15 degrees. Listening to these binaural speech samples via headphones confirmed that this configuration gave a very clear auditory image that would not sound as if it were located in the center of the listener's head (a rather unnatural sensation associated with monaural listening). The samples were recorded at a 48 kHz sampling rate using a Denon Model DTR-80P digital audio recorder. The samples were reproduced via Sony HL-90 headphones in the University of Aizu Language Media Laboratory. The stimuli were presented at a mean presentation level of 69 dB in each ear.

Procedure

The subjects were asked to identify each syllable they heard as containing either /f/, /θ/, /s/, /ʃ/, or /h/. These were natural speech (nonsense syllables) produced by three phonetically-trained male native speakers of English. To avoid the problem of sequential ordering, the stimuli were recorded in three randomized blocks. Before the test, a brief introduction to each of the five fricative sounds was administered and five-choice answer sheets were handed out to the subjects. For each stimulus, the subjects marked one of five possible responses and were asked to give a response to each item even if they were unsure of the identity of the fricative they heard. Four separate groups of students participated in the test. There was a pause of five seconds between each speech sample.

3. RESULTS and DISCUSSION

Table 1. Identification Scores (raw score/percentages).

	/f/	/s/	/ʃ/	/θ/	/h/
/f/	3,678 79.18%	146 3.14%	46 0.99%	461 9.92%	314 6.76%
/s/	14 0.30%	3,317 71.35%	168 3.61%	1,139 24.50%	11 0.24%
/ʃ/	8 0.17%	449 9.66%	4,085 87.89%	88 1.89%	18 0.39%
/θ/	595 12.80%	1,312 28.23%	125 2.69%	2,565 55.20%	78 1.08%
/h/	866 18.63%	24 0.52%	27 0.58%	78 1.68%	3,653 78.59%

The /ʃ/ had the highest correct response rate at 88%, and /s/ was the third highest at 71%. The confusability between these two fricatives was quite high, particularly within the /ɪ/ vowel in CV and VCV syllables. Here, the

number of /s/ responses for /ʃ/ and the number of /ʃ/ responses for /s/ increased considerably. (See Table 2.) Excluding syllables with the /i/ vowel, the correct response rate of /ʃ/ was 96%.

Table 2. The response rates of /ʃ/ and /s/ within /i/ (in percentages).

	/s/	/ʃ/	/θ/
/ʃi/	54.84	41.29	2.58
/iʃi/	49.68	42.58	6.77
/iʃ/	7.74	85.16	4.52
/si/	72.17	12.94	14.24
/isi/	56.77	14.84	28.39
/is/	43.87	2.26	53.55

The /θ/ was the most difficult fricative for the Japanese subjects to perceive. There were more /θ/ responses for /s/ (25%) and /s/ responses for /θ/ (28%) than responses from any other fricative, although the number of /f/ responses for /θ/ was quite high at 13%. (See Table 1.)

The response rates of /θ/ and /s/ also appeared to be influenced by vowel and syllable context. When the /ɛ/ vowel was excluded, the correct response rate of /θ/ within VC syllables increased from 39% to 75%. Also, within the /ɛ/ vowel, the response rate of /s/ increased considerably in all syllable positions. (See Table 4.)

The /f/ and /h/ both had the second highest response rate at 79%. At first glance, the overall response rate of /h/ was high. However, within the /u/ vowel, the response rates of both /f/ and /h/ significantly decreased, and the confusability between these two fricatives increased. When the /u/ vowel was excluded, the response rate of /h/ within CV and VCV syllables was 95%. Also, within the /u/ vowel, the number of /h/ responses for /f/ increased considerably within CV and VCV syllables. The number of /θ/ responses for /f/ within the /u/ vowel was also quite high. (See Table 3.)

Table 3. The response rates of /f/ and /h/ within /u/ (in percentages).

	/f/	/θ/	/h/
/fu/	56.45	12.90	23.55
/ufu/	75.16	3.55	20.00
/uf/	66.67	21.04	9.71
/hu/	43.55	2.26	54.19
/uhu/	55.81	0.97	43.23
/uh/	52.26	2.90	42.26

Table 4. The response rates of /θ/ and /s/ within /ɛ/ (in percentages).

	/f/	/s/	/θ/
/θɛ/	36.77	24.52	37.10
/ɛθɛ/	21.94	48.71	27.42
/ɛθ/	21.94	36.45	39.35
/sɛ/	0.65	94.19	3.87
/ɛsɛ/	0.00	89.68	7.10
/ɛs/	0.00	85.48	13.87

4. CONCLUSIONS

Overall, the results suggest the subjects had the most difficulty perceiving the English fricatives /θ/ within /ɛ/, /ʃ/ and /s/ within /i/, and /f/ and /h/ within /u/. The subjects had the least difficulty perceiving /s/ within /ɛ/, /ʃ/ in VC syllables within all vowel positions except /i/, /h/ in CV and VCV syllables, excluding /u/, and /f/ in all three syllable positions, excluding /u/.

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